

**UNITED STATES PATENT APPLICATION**

**OF**

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**FOR**

**ELECTRON GUN FOR CATHODE RAY TUBE**

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## **ELECTRON GUN FOR CATHODE RAY TUBE**

This application claims the benefit of Korean Patent Application No. 2002-0051541, filed  
5 on August 29, 2002, which is hereby incorporated by reference for all purposes as if fully set  
forth herein.

### **BACKGROUND OF THE INVENTION**

#### **Field of the Invention**

10 The present invention relates to an electron gun for a cathode ray tube, and more  
particularly, to an electron gun for a cathode ray tube driven using a dynamic focus method.

#### **Discussion of the Related Art**

The resolution of a cathode ray tube (CRT) is determined by characteristics of the  
electron beams. The characteristics include the focal point characteristics of the electron beam.  
15 In order to obtain quality images on the display, the electron beams landing on the phosphor  
screen must land on all areas of the phosphor screen. For example, the electron beams must  
land on the center and peripheral portions of the screen and have a small halo.

In the related art CRTs the electron beam holes for red (R), green (G), and blue (B)  
electron beams are arranged in an in-line configuration. A magnetic field is used to deflect  
20 electron beams into a pin cushion shape for a horizontal deflection and a barrel shape for vertical  
deflection. As a result, the focal point of the electron beams landing in the peripheries of the  
screen is distorted by astigmatism, which is caused by the non-uniform magnetic fields formed in  
the deflection apparatus. A reduction in the CRT resolution is caused by the distortion of the  
focal points of the electron beams in scanning peripheries and center, that is these focal points are

different.

Accordingly, a dynamic focus electron gun is employed in the related art CRTs to remedy this problem. Dynamic focusing refers to the application of a dynamic focus voltage. The dynamic focus voltage creates a higher focus voltage than the normal focus voltage when the peripheries of the screen are scanned by the electron beams. Accordingly, the focal point formation on the peripheries is compensated using this technique.

The electrons to which the dynamic focus voltage is applied are typically realized through two interconnected electrodes. The electrodes may be cup-shaped and/or plate-shaped or any combination thereof, and are generally welded together.

An electromagnetic field is formed in the area of the electron gun by a deflection magnetic field formed by the deflection apparatus. The voltage is synchronized with the horizontal deflection magnetic field signal, that is a part of the deflection magnetic field, and applied to the dynamic focus electrodes.

However, in the related art dynamic focus CRT systems, noise is generated in the area of the electron gun and interferes with the operation of the device, thereby reducing the quality of the device. Vibration of the dynamic focus electrodes generates the noise and the vibration is caused by a dynamic focus voltage applied to the electrodes. However, the dynamic focus voltage generates the electromagnetic field and electromagnetic force and causes the electrodes to vibrate.

Korean Laid-Open Patent No. 2001-0018045 discloses such a dynamic focus electron gun. Further, there is disclosed in Korean Laid-Open Patent No. 2001-0057789 an electron gun for a color Braun tube that improves an insertion depth structure of electrodes with respect to bead glass, and a structure for wires connected to electrodes and stem pins to reduce the noise.

However, in the above related art electron guns, the structure directly responsible for the generation of noise is not altered. Instead the structure in the general area is improved (i.e., the insertion sections of the electrodes that are inserted into the bead glass or the wire structure). Therefore, only a minimal reduction in noise is realized.

5 Noise is generated by the electrodes of the electron gun at specific frequencies, for example, at 7.4kHz or 12kHz. If an attempt is made to reduce noise by varying the specific frequency in the indirect and not the direct area of the noise source, that is, in the path through which the vibrations caused by the noise occur, then it becomes difficult to vary the frequency with respect to the noise source. Further, if the vibrations caused by the noise source pass  
10 through a path other than the one normally taken, then the effectiveness in reducing the vibrations through conventional methods decreases considerably.

### **SUMMARY OF THE INVENTION**

It is an aspect of the present invention to provide an electron gun for a cathode ray tube  
15 that reduces noise caused by a dynamic focus voltage.

An electron gun for a cathode ray tube includes a triode portion including cathodes, a first electrode, and a second electrode arranged with predetermined gaps therebetween. A plurality of electrodes arranged in sequence starting from a position adjacent to the second electrode. The electrodes receiving a voltage, for example, a constant voltage or a dynamic voltage. The  
20 dynamic voltage is synchronized with a deflection signal of electron beams. An anode electrode is positioned having a predetermined gap between the electrode arranged farthest from the cathodes. A support for supporting the electrodes at predetermined intervals. One of the electrodes is a multiple-element electrode that includes two interconnected sub-electrodes.

Gaps are formed between the sub-electrodes of the multiple-element electrode. The electrode may receive a constant voltage or a dynamic voltage, which is synchronized with a deflection signal of electron beams.

The sub-electrodes of the multiple-element electrode may be cup-shaped and/or plate shaped or any combination. The cup-shaped sub-electrodes have different dimensions, and the gaps are formed between ends of the sub-electrodes. The sub-electrodes may include a container having electron beam passage holes and a flange is formed extending from a circumference of an opening of the container. Additionally, the sub-electrode may include insertion members formed extended from the flange, the insertion members may be fixedly inserted into the support.

The cup-shaped sub-electrodes may have at least one identical dimensions and the gap may be formed between circumferences of the sub-electrodes. Protrusions may be formed on opposing surfaces of the cup-shaped sub-electrodes for connecting the sub-electrodes and forming a gap between the sub-electrodes.

In another aspect, one of the sub-electrodes of the multiple-element electrode is cup-shaped and the other sub-electrode is plate-shaped. The cup-shaped sub-electrode and the plate-shaped sub-electrode have at least one substantially identical dimension. A gap may be formed between circumferences of the sub-electrodes. Protrusions may be formed on opposing surfaces of the cup-shaped sub-electrodes, and the sub-electrodes are connected with the protrusions in such a way to form a gap.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

The accompanying drawings, which are included to provide a further understanding of the

invention and are incorporated in and constitute a part of this specification, illustrate  
embodiments of the invention and together with the description serve to explain the principles of  
the invention.

FIG. 1 is a sectional view of a cathode ray tube according to an embodiment of the  
5 present invention.

FIG. 2 is a perspective view of electron gun electrodes according to an embodiment of the  
present invention.

FIG. 3 is a graph illustrating the relationship between a sound pressure level (dBA) and  
frequency (Hz) of an electron gun according to a comparative example of the present invention.

10 FIG. 4 is a graph illustrating the relationship between a sound pressure level (dBA) and  
frequency (Hz) of an electron gun according to an embodiment of the present invention.

FIG. 5 is a perspective view of a multiple-element electrode for an electron gun according  
to another embodiment of the present invention.

15 FIG. 6 is a plan view of a multiple-element electrode for an electron gun according to  
another embodiment of the present invention.

FIG. 7 is a side view of a multiple-element electrode for an electron gun according to  
another embodiment of the present invention.

FIG. 8 is a side view of a multiple-element electrode for an electron gun according to  
another embodiment of the present invention.

20 FIG. 9 is an exploded perspective view of a multiple-element electrode for an electron  
gun according to another embodiment of the present invention.

FIG. 10 is a perspective view of a multiple-element electrode for an electron gun  
according to another embodiment of the present invention.

FIG. 11 is a perspective view of a multiple-element electrode for an electron gun according to another embodiment of the present invention.

### **DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS**

5           Reference will now be made in detail to various embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

FIG. 1 is a sectional view of a cathode ray tube according to an embodiment of the present invention.

10           Referring to FIG. 1, the CRT includes a panel 22 having a screen 20 formed on an inner surface of the panel 22, and a funnel 26 that may be connected to the panel 22. The screen 20 may include phosphor or any other suitable material. A deflection apparatus 24 may be arranged on a portion of the outer circumference of the funnel 26. A neck 30 may be connected to the funnel 26 and an electron gun 28 may be arranged therein.

15           A mask assembly may be arranged inwardly from the panel 22. The mask assembly includes a shadow mask 32 having a plurality of electron beam apertures formed therein, and a mask frame 34 for supporting the shadow mask 32. Further, an inner shield 36 may be connected to the mask frame 34 for shielding electron beams emitted from the electron gun 28 from the earth's magnetic field, when the electron beams are traveling toward the screen 20.

20           The electron gun 28 may be structured arranging three red (R), green (G), and blue (B) electron beam holes in an in-line configuration and adopts a dynamic focus method for operation. This will be described in more detail below.

          The electron gun 28 forms a triode portion that includes cathodes 28a, a first electrode 28b, and a second electrode 28c arranged in this sequence with predetermined gaps between

them. There are three of the cathodes 28a that are arranged in a line configuration corresponding to each of the R, G, B colors. Electron beam passage holes are formed in the first electrode 28b and the second electrode 28c corresponding to the cathodes 28a.

A plurality of electrodes 28d, 28e, 28f, and 28g are provided in this sequence starting after the second electrode 28c. These electrodes 28d, 28e, 28f, and 28g form a dynamic lens during operation of the electron gun 28. Electron beam passage holes are formed in the electrodes 28d, 28e, 28f, and 28g in a line and corresponding to the cathodes 28a, similar to those formed in the first electrode 28b and the second electrode 28c. The electrode 28e may be formed as a single unit. The electrode 28g may be formed of two sub-electrodes 280g and 282g (see FIG. 2).

During operation of the electron gun 28 a constant voltage ( $V_f$ ) or a dynamic voltage ( $V_d$ ) synchronized with a deflection signal of the deflection apparatus 24, is applied to the electrodes. The dynamic voltage ( $V_d$ ) refers to a varied voltage. That is, when the electron beams are deflected toward peripheries of the screen 20 the resulting spot of the electron beams is substantially identical to the electron beam on a center of screen 20.

The electron gun 28 also includes an anode electrode 28h arranged adjacent to the electrode 28g and positioned farthest away from the cathodes 28a. There is a predetermined gap between the anode electrode 28h and the electrode 28g. An anode voltage ( $V_e$ ) is applied to the anode electrode 28h through a shield cup 28i which is connected to the anode electrode 28h. A support 28j for supporting the electron gun 28 as described above. The support 28j may be made of bead glass or other suitable material, thereby forming a single integral assembly.

Electron beams generated by the triode section of the electron gun 28 pass through the above plurality of electrodes to be focused and accelerated toward the screen 20, to display

predetermined images.

The following structure is used in an embodiment of the present invention to reduce noise generated during operation of the electron gun 28. In particular, the electrode 28g formed of two sub-electrodes 280g and 282g as described above, is arranged such that there are gaps  
5 formed between the sub-electrodes 280g and 282g.

FIG. 2 is a perspective view of electron gun electrodes according to an embodiment of the present invention. In this embodiment the electrode arranged in the electron gun 28 may be formed from separate elements. That is, the electrode includes the sub-electrodes 280g and 282g. The sub-electrodes 280g and 282g are connected by welding or any other suitable method.  
10 These two sub-electrodes 280g and 282g may be both cup-shaped having different lengthwise dimensions (w1) and (w2). The sub-electrodes 280g and 282g include containers 2802g and 2822g. The containers may include electron beam passage holes 2820g, flange 2804g, flange 2824g arranged around a circumference of the containers 2802g and 2822g, and insertion members 2806g and 2826g arranged on the flanges 2804g and 2824g on opposite sides of the  
15 containers 2802g and 2822g. The insertion members 2806g and 2826g are arranged into the support 28j during manufacture of the electron gun 28. Further, the containers 2802g and 2822g may be formed to different heights (h1) and (h2), respectively.

In this multiple-element electrode 28g according to this embodiment, gaps 38 may be formed between the sub-electrodes 280g and 282g. The sub-electrodes 280g and 282g are  
20 arranged into a single electrode by welding or any other suitable method. The sub-electrodes 280g and 282g are arranged such that the insertion members 2806g and 2826g are in a state where portions of the flanges 2804g and 2824g are in close contact and the gaps 38 are formed between other areas of the flanges 2804f and 2824g. For example, gaps 38 are formed at the

ends of the sub-electrodes 280g and 282g.

A CRT that employs in its electron gun the electrode 28g as described has a substantial reduction in noise generation as compared to the related art CRT.

FIG. 3 is a graph illustrating the relationship between a sound pressure level (dBA) and frequency (Hz) of an electron gun according to a comparative example of the present invention.

FIG. 4 is a graph illustrating the relationship between a sound pressure level (dBA) and frequency (Hz) of an electron gun according to an embodiment of the present invention.

Referring to FIGs. 3 and 4, the electron gun of the present invention emits noise that is at or below 0dBA (A weighted decibel) at almost all frequencies. The electron gun of the comparative example generates noise that exceeds 0dBA at a significant number of the frequencies and at all levels of frequencies. Accordingly, the electron gun of the present invention is able to operate with a substantial reduction of noise and at a level that is inaudible to the human ear.

That is, by providing the gaps 38 between the sub-electrodes 280g and 282g that make up the multiple-element electrode 28g, friction between the sub-electrodes 280g and 282g caused by vibrations generated in the electrode 28g are reduced by the gaps 38, thereby minimizing the noise.

In the following embodiment variations of forming sub-electrodes and variations of the gap locations formed in the electrode will be described. However, a description of the operation will not be provided as the operation of the embodiments to be described is identical to that of the foregoing embodiment.

FIG. 5 is a perspective view of a multiple-element electrode for an electron gun according to another embodiment of the present invention. Referring to FIG. 5, the multiple-element

electrode 40 includes a cup-shaped sub-electrode 40a and a plate-shaped sub-electrode 40b.

Any combination of the electrodes may also be utilized. That is, the electrodes may be any combination of the cup-shaped sub electrode and plate-shaped sub electrode. For example, both electrodes may be cup-shaped or plate-shaped. Alternatively, the sub-electrodes may be cup-shaped and plate-shaped in any order. Sub-electrode 40a and sub-electrode 40b are arranged such that gaps 42 are formed near the end of the electrode 40. The gap 42 configuration is substantially identical to that described above with respect to the previous embodiment.

FIG. 6 is a plan view of a multiple-element electrode for an electron gun according to another embodiment of the present invention. Referring to FIG. 6, the multiple-element electrode 50 includes a cup-shaped sub-electrode 50a and plate-shaped sub-electrode 50b. In this embodiment a gap 52 is formed between and around the entire circumference of the sub-electrodes 50a and 50b. That is, a gap having a distance (a) and a distance (b) is formed between the sub-electrodes 50a and 50b. The gaps may be formed to be substantially identical to or greater than the thickness of the sub-electrodes 50a and 50b. This provides for a degree of error during manufacture or assembly, for example 0.1 mm.

FIG. 7 is a side view of a multiple-element electrode for an electron gun according to another embodiment of the present invention. Referring to FIG. 7, the multiple-element electrode 60 includes two cup-shaped sub-electrodes 60a and 60b. In this embodiment, the sub-electrode 60a and sub-electrode 60b are arranged so that they do not come into contact with one another. Protrusions 600a and 600b are formed on opposing surfaces of sub-electrode 60a and sub-electrode 60b, respectively. The protrusions 600a and 600b contact each other and are welded in this state. Any other suitable attachment method may be employed to attach the protrusions. A gap 62 is formed between the sub-electrode 60a and the sub-electrode 60b.

FIG. 8 is a side view of a multiple-element electrode for an electron gun according to a  
another embodiment of the present invention. FIG. 8 illustrates a multiple-element electrode 70  
that includes two sub-electrodes 70a and 70b. The sub-electrode 70a is plate-shaped while the  
sub-electrode 70b is cup-shaped. Protrusions 700a and 700b are formed on opposing surfaces  
of the sub-electrodes 70a and 70b, respectively. The protrusions 700a and 700b are in contact  
with each other and are welded in this state. Any other suitable attachment method may be  
employed to attach the protrusions. A gap 70 is formed between the sub-electrode 70a and the  
sub-electrode 70b.

FIG. 9 is an exploded perspective view of a multiple-element electrode for an electron  
gun according to another embodiment of the present invention. Referring to FIG. 9, the sub-  
electrodes 70a and 70b have substantially the same outer dimensions as shown in FIG. 4 of the  
present invention.

In the multiple-element electrode 60 according to an aspect of the present invention, the  
gap 62 size (c) and the gap 72 size (d) are greater than the thickness of at least one of the two  
sub-electrodes, thereby preventing deformation of the electrodes 60 and 70 by the electric fields  
formed in the area of the electrodes 60 and 70 during operation. The deformation causes  
undesirable frictions. The gap 62 size (c) and the gap 72 size (d) may be approximately three or  
more times thicker than at least one of the two sub-electrodes. That is, sub-electrodes 60a, 60b ,  
70a or 70b, which make up the electrodes 60 and 70, respectively substantially prevents  
weakness in the electrodes 60 and 70 and substantially prevents permeation of an electric field  
through the gaps 62 and 72.

FIG. 10 is a perspective view of a multiple-element electrode for an electron gun  
according to another embodiment of the present invention. Referring to FIG. 10, the multiple-

element electrode 80 includes sub-electrodes 80a and 80b that are interconnected, thereby forming a gap 82 between the sub-electrodes 80a and 80b. The sub-electrodes 80a and 80b have substantially rectangular surfaces 802a and 802b and include electron beam passage holes 800a and 800b formed through the surfaces 802a and 802b, respectively. The multiple-element electrode 80 may be formed by forming the sub-electrodes 80a and 80b in a flat rectangular configuration. For example, the formation may be accomplished by bending the rectangular configuration into insertion members and surfaces 802a and 802b and the insertion members are arranged together and welded. Additionally, any other suitable method could also be used in the formation process.

FIG. 11 is a perspective view of a multiple-element electrode for an electron gun according to another embodiment of the present invention. Referring to FIG. 11, a multiple-element electrode 90 includes sub-electrodes 90a and 90b, a gap 92, surfaces 902a and 902b, and electron beam passage holes 900a and 900b. The electrode 90 is formed identically to the electrode 80 of FIG. 10, except that short ends of the sub-electrodes 90a and 90b are also bent in a direction toward each other when interconnected. Accordingly, a gap 92 is defined by the space between the short ends of the sub-electrodes 90a and 90b.

The multiple-element electrodes 80 and 90 are formed differently from the electrodes of the other embodiments described above. The size (e) of the gap 82 formed by the sub-electrodes 80a and 80b and a size (f) of the gap 92 formed by the sub-electrodes 90a and 90b are larger than a thickness of at least one of the sub-electrodes. That is, the size (e) or (f) is larger than a thickness of 80a, 80b, 90a, or 90b, thereby preventing deformation of the electrodes 80 and 90 by the electric field formed in the vicinity of the electrodes 80 and 90 during operation of the electron guns preventing generation of friction.

The electron gun for CRTs of the present invention structured and operating as described above, reduces the noise caused by friction between elements during operation of the CRT. As result, the quality of the images displayed by the CRT is significantly improved.

Although preferred embodiments of the present invention have been described in detail  
5 hereinabove, it should be clearly understood that many variations and/or modifications of the basic inventive concepts herein taught which may appear to those skilled in the present art will still fall within the spirit and scope of the present invention, as defined in the appended claims.